

R ciprocating Piston Drive Mechanism

PATENT CLAIMS

1. Reciprocating piston drive mechanism, especially for a reciprocating piston vacuum pump, comprising a housing (2), a cylinder (3) embodied in said housing, a piston (4) moving back and forth in the cylinder and an electromagnetic drive for the piston (4) that has an electromagnet (11) on the stator side and at least one permanent magnet (18, 19) on the piston side **wherein** permanent magnets (15, 16) be also provided on the stator side and that the permanent magnet (20) respectively the permanent magnets (18, 19) of the piston (4) and the permanent magnets (15, 16) of the stator be configured and disposed in such a way that the piston (4) adopts a substantially central axial position in the idle state.
2. Drive mechanism according to claim 1, **wherein** the piston (4) is equipped on each of its face sides with one each permanent magnet (18, 19 respectively) and where in each instance a permanent magnet (15, 16 respectively) be located in the area of the face sides of the cylinder (3).

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3. Drive mechanism according to one of the claims 1 or 2, **wherein** the permanent magnets (15, 16) on the stator side are located in cylinder (3) and where the face sides of the piston (4) are in each instance equipped with recesses, which correspond to the dimensions of the permanent magnets (15, 16) on the stator side.
4. Drive mechanism according to one of the claims 1 to 3, **wherein** on the stator side a pole component (yoke) (11) be provided with a cross section having a U-shape and the U-limbs of which end at the level of the permanent magnets (15, 16) on the stator side.
5. Drive mechanism according to claim 4, **wherein** the U-shaped pole component (11) encompasses one or several coils (8, 8', 8'') from three sides.
6. Drive mechanism according to claim 5, **wherein** there is located between the coil(s) and the cylinder (3) a further, pole component (12) shaped approximately like a pipe section.
7. Drive mechanism according to one of the above claims, **wherein** axially arranged pole components (21 to 24) be assigned to the permanent magnets (18, 19) at the piston (4).
8. Drive mechanism according to claim 1 or 2, **wherein** the piston is equipped only with a single permanent magnet (20) situated approximately centrally in the axial direction.
9. Drive mechanism according to claim 8, **wher in** there is located one each permanent magnet (15, 16) on the stator side at the side of the permanent magnet (20) on the side of the piston and where the distance of the

permanent magnets (15, 16) on the stator side corresponds to the amplitude of the piston's motion.

10. Drive mechanism according to claim 8 or 9, **wherein** two coils (8', 8'') are provided the axial direction next to each other, where a yoke (11) encompasses the coils, where the face side of a central yoke component (11') encompasses the permanent magnet (20) on the side of the piston and where the face sides of the inner axially extending yoke components rest from the outside against the permanent magnets (15, 16) on the stator side.
11. Drive mechanism according to one of the claims 1 to 10, **wherein** it is of a rotationally symmetrical design and where the permanent magnets (15, 16, 18, 19, 20) are each of ring-shaped design.
12. Drive mechanism according to one of the claims 1 to 11, **wherein** the pole components and/or the magnetic forces are arranged, resp. selected to be axially symmetrical.
13. Drive mechanism according to one of the claims 1 to 11, **wherein** the pole components and/or the magnetic forces are arranged, resp. selected to be axially asymmetrical.
14. Drive mechanism according to one of the above claims, **wherein** it is equipped with sensors (31, 32) for detecting the piston's position.
15. Reciprocating piston vacuum pump with a drive mechanism according to one of the claims 1 to 14, **wherein** at least one of the two chambers (34, 35) created by piston (4) and cylinder (3) be equipped with an inlet valve and a discharge valve.

16. Pump according to claim 15, **wher in** an inlet line (36) is provided opening at the side into the chamber, the opening of said inlet line forming together with the piston (4) an inlet valve.
17. Pump according to claim 15 or 16, **wherein** pressure or piston controlled discharge valves (41, 42) are provided.
18. Pump according to claim 17, **wherein** the closure pieces (43, 44) of the discharge valves (41, 42) are designed as discs and extend substantially over the entire cross section of the cylinder (3).
19. Pump according to claim 18, **wherein** the closing motion of the discs (43, 44) is effected by the resilient forces of springs.
20. Pump according to claim 18, **wherein** the closing motion of the discs (43, 44) is effected by the magnetic forces.
21. Pump according to claim 20, **wherein** the discs (43, 44) are made at least partly of a ferromagnetic material and where the outer face side of permanent magnets (15, 16, 15', 16') on the stator side forms the valve seat.
22. Pump according to one of the claims 15 to 21, **wherein** one or several cylinder/piston pairs (3, 4, 3' 4') are accommodated in the housing (2).
23. Drive mechanism or pump according to one of the above claims, **wherein** switching means (63, 66, 67) for driving the coil(s) (8, 8', 8'') are provided, said

switching means being driven by sensors (31, 32) or other signals dependent¹⁾ on the piston's position.

24. Method for operating a pump or a drive mechanism according to claim 13, **wherein** the frequency of the piston's motion and/or the maximum current flow in the coil(s) is pre-set.
25. Method according to claim 24 **wherein** the motion is reversed already before reaching the end position.
26. Method according to claim 24 or 25 for operating a pump according to claim 22, **wherein** the related drive mechanisms are so controlled, that the pairs of pistons (4, 4') will reciprocate in opposite directions.
27. Piston for a reciprocating piston pump according to one of the claims 15 to 22, **wherein** it is composed of two pot components (70, 71) which in the area of their open face sides are equipped with joining means (72, 73).
28. Piston according to claim 27 for a pump according to one of the claims²⁾ 8 to 10, **wherein** the pot components (70, 71) are equipped in the area of their open face sides with rims (74, 75) which in the assembled state form a ring groove (76) for accepting the magnet ring (20).

¹⁾ **Translat r's not** : In the German text the word "kolbenlagerabhängig" (dependent on the piston's bearing) is used where "kolbenlageabhängig" (dependent on the piston's position) would be more appropriate and in line with the remaining text. The latter meaning has been used in the translation.

²⁾ **Translat r's not** : In the German text the word "ansprüche" is should have been spelled as "Ansprüche".